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MANUFACTURING CELL SIMULATION

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Abstract This paper demonstrates the value of using simulation to model a gear manufacturing cell at the Reliance Electric Co. for the purpose of evaluating changes in equipment, layout, operator tasks and operating policies.

Keywords: Simulation, discrete simulation, manufacturing, manufacturing cell, gear manufacturing.

INTRODUCTION

The Reliance Electric Co. manufactures gear-reducers at one of their plants in the Southeast. This plant, being fairly new, was organized into a group of manufacturing cells. We were approached by Reliance, through the Center for Automated Manufacturing at Clemson University, to look at improving the general efficiency of their operations at this plant. As an entree to the study, we simulated the operation of their high-volume gear (HVG) cell in order to evaluate the effect on the cell efficiency of changes in equipment, layout, operator tasks and operating policies.

The HVG cell was divided into two serial groupages of machinery, each with its own operator. The first machine group included chuckers, scrapers and broaches; the second group included hobbers, washers, deburrers and shavers. There was little or no interaction between the two operators.

SIMULATION MODEL

In order to model the HVG cell, it obviously was necessary to flow-chart the operation of the cell in considerable detail and to acquire operational data. As with most studies of this type, the operators did not always follow the approved methods, and sufficient data was not available. Hence, it was necessary to "standardize" the operations and to set up a procedure for collecting the required data.

The model was written in GPSS V (IBM) and simulated in detail, including the movement of operators, the operation of each machine, and, hence, the flow of material through the cell. Machine breakdown, operator PF&D, hob changes, and machine setups were included in the model. In reality each operator represented a separate model; the first one feeding the second. Once the model of the existing system was simulated, it was validated with respect to the existing system. The model had 1800 GPSS statements and required 1.75 minutes on an IBM 370/3081 to simulate 5 weeks of operations.

After validation of the model was completed, we worked with the plant manager and his staff to develop scenarios of changes to be evaluated that might improve the efficiency of cell operations. These changes included:

1. Machine processing times
2. Machine replacement
3. Hob life
4. Operator interaction
5. Product sequence

The effects of using faster new machines, changing process times on existing machines and increasing hob life were evaluated similarly by simply changing the appropriate times within the model. To change operator tasks, particularly where one operator crosses from his area to help the other operator, took a considerable amount of reprogramming. This operator interaction, however, was programmed so that it could be switched off and on easily.

Changes in the sequencing of product through the cell were easily managed by simply changing the product input ordering. An analytic method was developed for "optimally" scheduling production through the cell. The simulation model was used to verify the results of the analytic method.

RESULTS AND CONCLUSIONS

The cell parameters listed above were changed systematically to measure the individual and interactive effects on the cell efficiency. The results were then presented to management. In some cases, such as when the cycle time for a single machine was decreased, management was mildly surprised that the change did not have as great an effect on overall cell efficiency as they had expected. The greatest gains in efficiency for this cell came from decreasing the chucker and shaver (bottleneck machines) cycle times and by increasing the time the hob is used before it is replaced with a sharpened one. Increased operator interaction was not of significant value.

The model developed for Reliance's HVG cell was not a one-shot wonder. Some of the plant manager's staff were trained in its use. The model has since been modified to reflect actual changes in the cell and is still being used to evaluate various alternatives.

REFERENCES

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